



photo: steven a. gunther

# DAVID ROS ENBOOM

# INVISIB LEGOLD

PO  
ETS

# DAVID ROSENBOOM • INVISIBLE GOLD

## Portable Gold and Philosophers' Stones • On Being Invisible

Classics of live electronic music involving extended musical interface with the human nervous system.

### Introduction

"The creating of spontaneous simultaneity, the allowing for meaningful synchronicity, as a common recognition function for two or more living aggregates or non-entropic entities, is a basic drive of soul." When I wrote this in my 1975 book, Biofeedback and the Arts. Results of Early Experiments, it was a kind of mystical cyberneticist's way of developing a definition of life. Today, it preserves some of the spirit with which, over many years, I have investigated the workings of the human brain by inventing musical circumstances in which the brain's electrical activity was integrated into the interactive dynamics of self-organizing, electronic music systems. The release of this CD preserves some important examples from this exploration.

In part, this work is about transforming invisible, inner attainments into visible miracles. It is about submerging one's self into natural processes in order to learn the relationships between resonance and the idea of initiating action, how willful creation relates to spontaneous simultaneity and being an active part of something ongoing, which is larger than ourselves. The journey has produced a wealth of observations and inferences about the brain and its relationship to music, musical mind, the organization of perception, the synthesis of memory, performance, composition and musical manifestations of psyche.

This music is also about bringing musical symbols to bear on a vision, a view of the connectedness and morphology of the universe. Central to this are ideas about resonance, evolution, self-

organization, and emergent processes. The idea of *resonance* is a particularly potent theme in my music. It is about creating something from nothing and the emergence of perceivable substance from the tiniest reinforcements in patterns of energy flow. These may be mere wisps of ineffable quantum resonance hinting at the existence of ponderable matter, the steady eons of order producing evolving universes, brain/body holograms enfolding memories, or spirit links uniting souls. They all emerge from waves of resonance on both ethereal and physical planes. The very possibility of enduring memory, the accumulation of which helps to produce our sense of self, is made manifest through resonant processes. Through practice, our awareness of these enduring resonances, the foundation of what we perceive as solid, can become more immediate and natural.

Much of the work was carried out with the aid of advanced technology. It enabled me to directly monitor electrical activities manifesting inside the brain, to extract detailed features of this activity with the potential to illuminate my musical investigations, and to use the results to grow musical forms with electronic instrumentation. It also enabled me to explore new territories for personal and public, musical performance, and to experience the magical "dissolution of a concept into an image," through those wonderful "moments when ideas dissolve into music," (Huizinga, J. The Autumn of the Middle Ages).

### Portable Gold and Philosophers' Stones (Music from Brains in Fours) (1972)

In reading about mantric symbols, I came across the idea of "The Philosopher's Stone," (Govinda, Lama A. Foundations of Tibetan Mysticism), an enduring, invisible, mental symbol that is about the *prima materia*, the original substance, the ultimate principle of the universe. It is said that by returning from the qualities of sensation and thought which we perceive through differentiation and specialization to the undifferentiated purity of the *prima materia*, we may learn the truth about creative power and the fundamental mutability of all phenomena. The symbol of *Portable Gold* is my way of emphasizing the *timelessness* and *spacelessness* of this idea, which we can carry with us anywhere. To manifest these symbols in music, this piece makes use of resonant coincidences detected among the physical brainwaves of up to four performers. Here, resonance links the spiri-

tual, the exploration of the human soul, and the physical, the exploration of matter, the unification of which is said to lead to the *Elixir of Life*. This elixir is described as achieving *natural power over the elements*.

On the music's physical plane, the metaphor of resonance manifests on many levels. First, all the electronic sounds are controlled by the brainwaves of the four biofeedback musicians. The music progresses as these brainwaves move in and out of synchrony with each other, and their coherence over time fluctuates. The musicians are listening to their parts and attempting to achieve the internal states required to gain facility in influencing these signals. Coherence may be thought of as the degree of stability in the patterns of relatively smooth waveforms. Several frequency bands in the brainwaves are monitored and various correlation techniques used to detect this synchrony and temporal coherence. As these values change, the range of control over sound given to each performer's brain is increased or decreased. When that range is increased, we hear more florid, active, and detailed movement in the musical lines of the corresponding parts, like trills, ornaments, and wider pitch excursions.

The sounds are produced with a bank of resonant filters, known as a *Holophone*. The inputs to the Holophone consist of four-note chords made of pulse waves. The chords are produced by frequency dividers, which also respond to the analysis of brainwaves—in some versions galvanic skin response and body temperature are also monitored. Thus, chords derived from the sub-harmonic or undertone series of a fixed pitch produce the source sounds for the Holophone, which produces its music from the combined harmonic series of all the notes in the chord. As the performers produce more and more coherent brainwaves, the voices in the chord tend to move lower and lower. Subtle internal processes are required for the performers to enjoy the music, but not allow this enjoyment to disrupt the state of consciousness required to maintain the coherent brainwaves. Zen-like meditative disciplines emphasizing calm alertness are particularly effective.

The music begins with a drone. Slowly, as the brains, minds, and bodies relax and settle, coherent

waves begin to emerge, the resonators of the Holophone begin to move, and musical shapes follow. As this process continues, the pitch range inscribed by these shapes increases, and the music becomes more active. About three-quarters of the way through, the descending, pulse-wave chords converge to a unison tone, resolving on a low-pitched tonic. Grand sweeps and cascades rising through harmonic space ensue from this climax. Ironically, the excitement so generated carries with it the inevitable cost of such ebullience, the brainwaves become more desynchronized and their range of control over the sound decreases. As a result, the chords move into more quizzical, though poignant, harmonies, and finally, the tones settle onto an acceptable, concluding chord. The music ends gently and thoughtfully.

### **Portable Gold... Technology and Recording Credits**

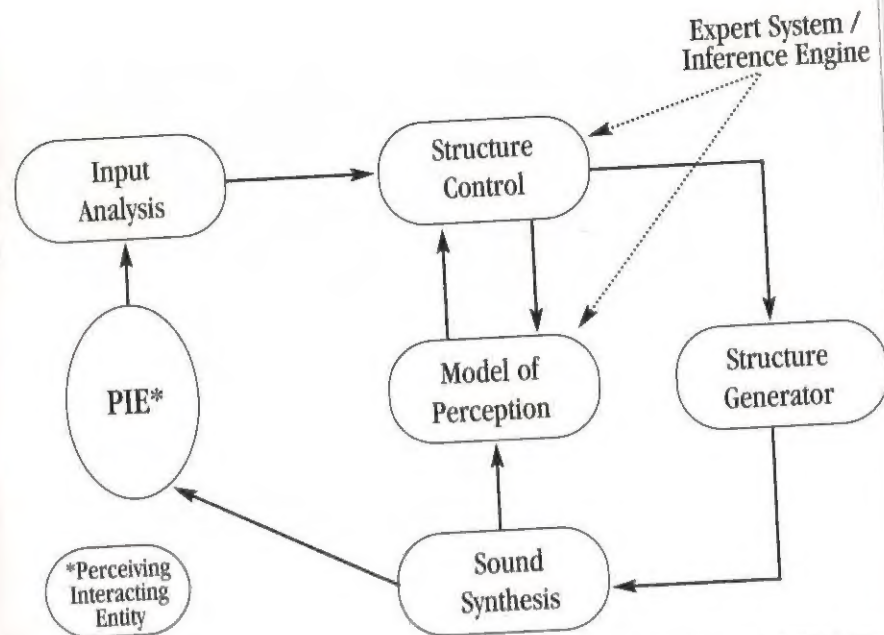
The pulse wave chords were produced by Neurona Company *Omniwoila* modules, which I designed in 1968 and manufactured and distributed with my friend William Rouner in New York in 1969. The Holophone was constructed from filters made by ARP Instruments in Newton, MA. The analysis equipment included brainwave amplifiers, a Correlation Function Computer, and a Fourier Analyzer by Princeton Applied Research, and filters by Krohn Hite. I also designed and built additional interface electronics, envelope followers, analog gates, and threshold detectors.

This version of *Portable Gold...* began with a source tape from a performance at the International Carnival of Experimental Sound held at The Roundhouse in London, England in 1972. The performers were from the group *Biome*, including Pat Strange, Alan Strange, Marilyn McCarty, and Frank McCarty. The tape was subsequently re-mastered at the York University Electronic Media Studios in Toronto, with the assistance of Robert Richards, for the record *Brainwave Music—David Rosenboom*, released by the Aesthetic Research Centre of Canada, in Maple, Ontario, in 1974, #ST1002. For this CD, the analog recording was converted to digital and reprocessed in the composer's studio at the California Institute of the Arts in order to enhance the stereo image and the distinctiveness of the four individual parts.

### On Being Invisible (1976-77)

*On Being Invisible* is a self-organizing, dynamical system, rather than a fixed, musical composition. The title refers to the role of an individual within an evolving, dynamical environment, who makes decisions concerning when and how to be a conscious *initiator* of action and when simply to allow his individual, internal dynamics to co-evolve within the macroscopic dynamics of the system as a whole. A potpourri of brainwave analysis techniques is used to track shifts of attention and changes in the state of consciousness of a solo performer that are concurrent with specifically identified musical events. The results are used in a feedback structure to influence the evolution of an emerging musical form, which will be unique in each performance. Several versions of *On Being Invisible* have been created, including a recent, self-organizing, multi-media opera, in which the detection and analysis of *event related potentials* in the brains of two performers directs an evolving, on-stage scenario. This system has been described as an *attention dependent sonic environment*.

Each version of *On Being Invisible* has included the following major components implemented in software or hardware: (1) a musical *structure-generating mechanism* coupled to a *sound synthesis system*; (2) a *model of musical perception* that detects and makes predictions about the perceptual effects of various phenomena in an unfolding musical structure; (3) a *perceiving, interacting entity* (human performer); (4) an *input analysis system* for detecting and analyzing bioelectromagnetic and other input signals; and (5) a *structure-controlling mechanism* that directs (1) and updates (2) in response to corresponding information from (4) and (2). In short, the system generates musical changes, predicts the significance with which they may be perceived, and tests for brain signals that either confirm or disconfirm these predictions. If the predictions are confirmed, the kinds of changes associated with the predictions will be reinforced in the music. If they are disconfirmed, the music will be allowed to evolve into new territory. The performer may attempt to direct changes by controlling his own attention shifts—something requiring great discipline—or simply allow his natural tendencies in listening to manifest their effects on the evolving music.



#### Some Rule types :

**Music:** compositional (intent), structural, morphological dynamics  
**Perception:** feature extraction, boundary detection (segmentation), holarchic form  
**EEG:** decomposition, states, event related potentials

**Potential Organization of Intelligent Input Analyst and Musical Expert System/Inference Engine for Live Performance**

The version contained on this CD represented a milestone in implementing this vision. In *Part I*, the sounds have a stochastic beginning, though phrases immediately become captured and developed in response to what the brainwaves reveal about how they are perceived. As the performer's attention and state of consciousness shift, the music tends to converge towards order and, then, diverge away from it, as new things in the sonic fabric develop greater perceptual gravity. At a certain point, about half way through, a part of the software capable of building structural hierarchies in music is activated. As phrases are captured and grouped together to make larger patterns, regular rhythms begin to appear. Still, the system makes predictions about how elements in these pattern groups may be perceived, such as the degree of expectancy or surprise that may be associated with them. Again, the brainwave responses will confirm or deny these predictions and cause the music to build more complex order or mutate in new, unpredictable directions. Finally, the performer's improvisational sensibility determines a suitable stopping point.

In *Part II*, the musical paradigm is about the performer interacting with a non-equilibrium system, a system in which complimentary resonances produce tendencies to settle into stable patterns. These system states become displaced when the performer initiates change by making small sounds into a microphone. He does this only occasionally and at carefully chosen moments. The system then attempts to adjust its own internal resonances to incorporate those contained in the new sounds, grouping them into relatively stable, balanced, homeostatic patterns. This process of settling and displacement combined with the capacity to evolve characterizes the *instrument* being played. Thus, the results of working with brain signals to develop self-organizing, musical systems are applied in a different musical context. Much of the software used in *Part I* to build and evolve musical structures is also employed here. However, the inputs and analyses are derived from acoustic sources, rather than from brainwaves.

Metaphors about the concurrency and succession of events in undefined spaces and the spread of energetic phenomena throughout resonant fields operate heavily in this music. Perhaps, they may lead us forward in developing the potential of untapped sensibilities still residing deep within us.

Perhaps, we will be able to conceive of an idea of resonance unbounded by our limited views of time and space and expand our appreciation of the universality of music even more.

### **On Being Invisible Equipment and Recording Credits**

The brainwaves were processed by amplifiers and a Correlation Function Computer from Princeton Applied Research. An Interdata, Model 74 minicomputer with paper tape reader, Lear-Siegler ADM-3 CRT terminal, and analog-to-digital and digital-to-analog converters was used to run my software for creating self-organizing musical forms in response to the brain signals. I also built brainwave filters, envelope followers, and custom interface equipment to control a set of Buchla and Associates, 200 Series, electronic music modules and Music Easel. These and, in *Part II*, a pair of Tibetan finger cymbals, a snake charmer's horn, a little bit of voice, and a monkey drum, were responsible for all the sounds. Touch sensors are also used to direct the software and initiate a few sounds in counterpoint with the brainwaves.

Michael Brook recorded this performance of *On Being Invisible*, in which I was the solo performer, at the Music Gallery in Toronto on February 12th, 1977. William Stevens, Larry Polansky, and Jacqueline Humbert provided additional assistance in this concert. The tape was converted to digital format and a touch of reverberation added at the Center for Contemporary Music at Mills College in Oakland, California in 1989. The analog version was released on the record, *On Being Invisible—David Rosenboom, a solo electric concert utilizing hybrid-computer wave analysis and sound synthesis, brain signals, touch sensors, and small acoustic sources*, by Music Gallery Editions, Toronto, in 1977, #MGE 4. Generous assistance in developing this work was provided by the Canada Council, for which I am very grateful.

### **Related Information**

A score for *Portable Gold and Philosophers' Stones*, dedicated to Ted Coons, was published in my book, *Biofeedback and the Arts. Results of Early Experiments*, by the Aesthetic Research Centre of Canada, first edition 1975, second edition 1976, Vancouver, British Columbia. Remaining copies are available from Frog Peak Music, PO Box 1052, Lebanon, NH 03766, email: [fp@frogpeak.org](mailto:fp@frogpeak.org), website: [www.frogpeak.org](http://www.frogpeak.org). A fully com-

prehensive description of the research, a history of ideas, and technical information about this work was published in my monograph, Extended Musical Interface with the Human Nervous System. Assessment and Prospectus, Leonardo Monograph Series, No. 1, by the International Society for the Arts, Sciences and Technology, San Francisco, CA in 1990. The MIT Press, Electronic Journals, Cambridge, MA, published a Revised Version in 1997 as an electronic document on the World Wide Web at:

<http://mitpress.mit.edu/e-journals/Leonardo/isast/monographs.html>

David Rosenboom  
Valencia, California  
August, 2000

**David Rosenboom** (b. 1947) has been widely acclaimed as a pioneer in American experimental music since the 1960's. He is a composer, performer, conductor, interdisciplinary artist, author, and educator, having explored ideas in his work about the spontaneous evolution of forms, languages for improvisation, new techniques for ensembles, cross-cultural collaborations, performance art, computer music systems, interactive multi-media, compositional algorithms, and the structure of the brain and nervous system. He has composed extensively for both instrumental and technological media and his work has been widely disseminated around the world. Rosenboom has been Dean of the School of Music and Conductor of the New Century Players at the California Institute of the Arts since 1990 and was Co-Director of the Center for Experiments in Art, Information and Technology from 1990 to 1998. He taught at Mills College from 1979 to 1990, was Professor of Music, Head of the Music Department, Director of the Center for Contemporary Music, and held the Darius Milhaud Chair from 1987 to 1990. He studied at the University of Illinois with Salvatore Martirano, Kenneth Gaburo, Lejaren Hiller, Soulima Stravinsky, Paul Roland, and Gordon Binkerd, among others, and has worked and taught in innovative institutions, such as the Center for Creative and Performing Arts at SUNY in Buffalo, New York's Electric Circus, York University in Toronto, where he was Professor of Music and Interdisciplinary Studies, the University of Illinois, where he was awarded the prestigious George A. Miller Professorship, New York University, the Banff Center for the Arts, Simon Fraser University, the Aesthetic Research

Centre of Canada, the San Francisco Art Institute, and the California College of Arts and Crafts. His most recent works include *Bell Solaris* (twelve movements for piano) and *Seeing the Small in the Large* (six movements for orchestra), which explore new ideas about counterpoint and musical transformation, and a self-organizing, multi-media opera involving brain signals, *On Being Invisible II (Hypatia Speaks to Jefferson in a Dream)*. He has written extensively about his ideas on compositional modeling, which he terms *Propositional Music*. For additional information on the author's work, see the World Wide Web site:

<http://music.calarts.edu/~david>

All compositions are by David Rosenboom.

Copyright © David Rosenboom 2000.

Published by David Rosenboom Publishing (BMI).

Cover design: Matthew Schickele

Pogus Productions  
50 Ayr Road  
Chester, NY 10918-2409

[www.pogus.com](http://www.pogus.com)

[pogal@frontiernet.net](mailto:pogal@frontiernet.net)

